DISCOVERY

Biotechnological synthesis of silver nanoparticles of *Indigofera aspalathoids* leaf extract

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ABSTRACT

Nanotechnology is gaining much importance in the current century because of its capability of modulating metals into their nano-size. The present study deals with the synthesis of silver nanoparticles using the *Indigofera aspalathoids* leaf extract. The complete reduction of silver ions was observed after 48 h of reaction at 30° C under shaking condition. The color changes in reaction mixture (watery to dark brown color) was observed during the incubation period, because of the formation of silver nanoparticles in the reaction mixture enables to produce particular color due to their specific properties. The synthesized nanoparticles are confirmed by color changes and it was characterized by UV- spectroscopy, FTIR and SEM studies.

Key words: Nanoparticles; Silver ions; FTIR; UV spectroscopy; SEM.

Abbreviations: SEM - Scanning Electron microscope; FTIR - Fourier transforms infrared spectroscopy; NM - nanometer; Ag+ ions - Silver ions; Rpm - revolutions per minute; ml - microliter; $AgNO_3$ - silver nitrate.

1. INTRODUCTION

Nanotechnology could be attributed to their small sizes and large surface areas (Anima Nanda and Saravanan, 2009). Nanoparticles are being sighted as fundamental building blocks of nanotechnology. In recent years, the research is mainly focused on the metal nanoparticles due to their unique optical, electronic, mechanical, magnetic, and chemical properties that are significantly different from those of bulk materials (Mazur, 2004). New applications of nanoparticles and nanomaterials are emerging rapidly (Parashar et al., 2009). In nanotechnology, silver nanoparticles are the most prominent one. Silver nanoparticles can be synthesized by various techniques which includes chemical reduction of silver ions (Liz-Marzan and Lado-Tourino, 1996). But most of these methods are

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extremely pricey and also uses toxic, hazardous chemicals, which may create potential environmental and biological risks. So there is a need for green chemistry that includes a clean, non toxic and environment friendly method of nanoparticles synthesis. Biological methods of nanoparticle synthesis using microorganisms (Nair and Pradeep, 2002; Konishi and Uruga, 2007), enzymes (Willner et al., 2006), fungus (Vigneshwaran et al., 2007), and plants or plant extracts (Shankar et al., 2004). *Indigofera aspalathoids*, a low under shrub plant belongs to the family Pappiloncea in distribution in all tropical countries, including India. The plant has been widely acknowledged for the treatment of leprosy and cancerous affections. The leaves flower and tender shoots are considered to have active ingredients (Kirtikar and Basu, 2000). In this paper, we are the first to report on the biosynthesis of metallic nanoparticles of silver by the reduction of aqueous Ag+ ions using *Indigofera aspalathoids* leaf extract.

Figure 1
The whole plant of *Indigofera aspalathoids*

2. MATERIALS AND METHODS

2.1. Collection and Extract Preparation

The leaves of the plant *Indigofera aspalathoids* (Fig.1) were collected from the Trichy district. The leaves were allowed to dry for 10 days at room temperature. The leaves were powdered. The plant leaf broth solution was prepared by taking 20g of finely powdered leaves in a 300mL Erlenmeyer flask with 100mL of sterile distilled water and then boiled the mixture for 5 min. The mixture was centrifuged at 10,000 rpm for 15 min. The supernatant was collected & stored at 4° C.

2.2. Synthesis of silver nanoparticles

1mM aqueous solution of Silver nitrate ($AgNO_3$) was prepared (Fig.2a). To the 5 ml of leaf extract 100 ml of 1 mM $AgNO_3$ aqueous solution was added in conical flask of 250 ml and kept at room temperature. The flask was thereafter put into shaker (150 rpm) at 30°C and reaction was carried out for a period of 48 hrs.

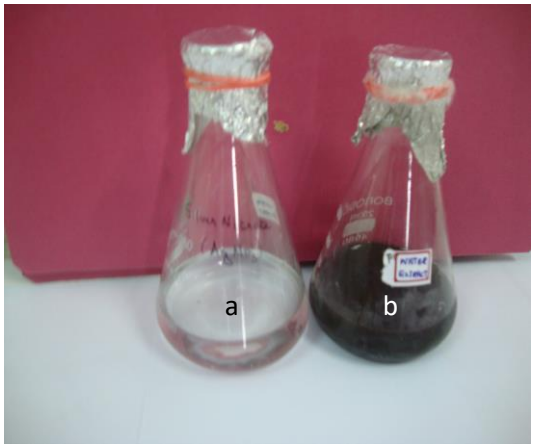

Figure 2
(a) 1mM silver nitrate solution, **(b)** 5ml of leaf extract in 100ml of 1mM silver nitrate after 48hrs of incubation

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2.3. UV-VIS Spectra analysis

The reduction of pure Ag+ ions was monitored by measuring the UV-Vis spectrum by diluting a small aliquot of the sample into distilled water. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer at the range of 200-800 nm.

2.4. FTIR analysis

FT-IR measurement of sample was performed using Nicolet Avatar 600 FT-IR spectrophotometer.

2.5. SEM analysis silver nanoparticles

Scanning Electron Microscopic (SEM) analysis was done using Thermo scientific SEM machine.

3. RESULTS AND DISCUSSIONS

Synthesis of nanoparticles is important in modern nanotechnology because of its wide application in various fields especially in medicine. The present investigation demonstrates the formation of the silver nanoparticles by the reduction of the aqueous silver metal ions during exposure to the plant leaf extract for 48 hrs. The concentration of the extract also plays a major role in the synthesis of nanoparticles.

As the *I.aspalathoids* leaf extract was mixed in the aqueous solution of the silver nitrate solution (Fig.2b). Reduction of silver ions to silver nanoparticles could be followed by a color change and UV-Vis spectroscopy. The technique mentioned above has proven to be very useful for the analysis of nanoparticles (Henglein, 1993; Sastry et al., 1997; Sastry et al., 1998). Formation of silver nanoparticles from 1mM silver nitrate was confirmed using UV spectral analysis. Characterization by UV-Vis spectroscopy is one of the most widely used techniques for structural characterization of silver nanoparticles (Sun et al., 2001). Fig.3 shows the UV-Vis spectra outcomes.

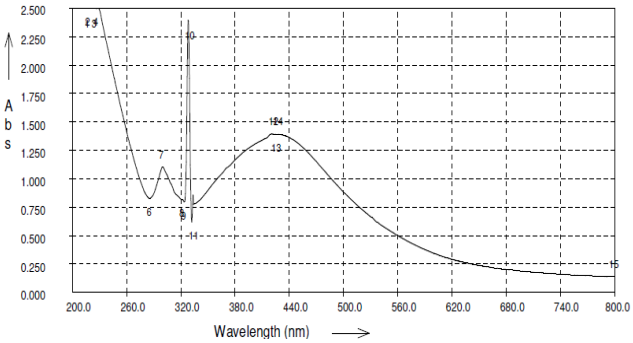

Figure 3
UV-vis spectra of Ag nanoparticles

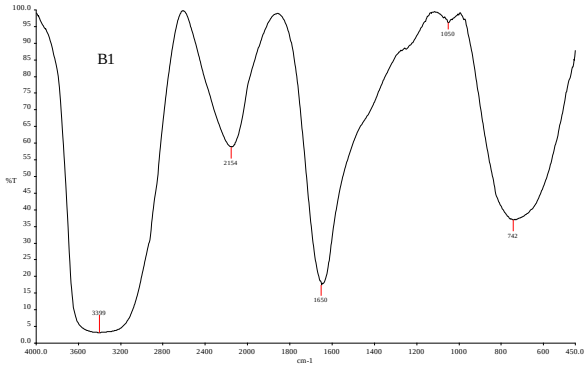

Figure 4
FTIR spectrum of silver nanoparticles

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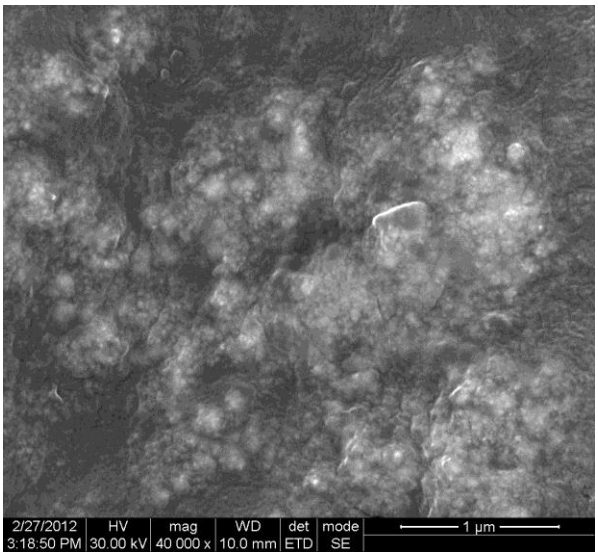

Figure 5
SEM images of synthesized silver nanoparticles

The FTIR spectra of the plant extract after the synthesis of nanoparticles were analyzed which discuss about the possible functional groups for the formation of nanoparticles. The FTIR spectrum (Fig.4) shows prominent absorption peaks at 3399 cm-1, 2154cm-1, 1650 cm-1, 1050 cm-1, 742 cm-1. The representative spectra of nanoparticles obtained manifests absorption peaks located at about the band at 3399 cm-1 corresponds to O-H stretching H-bonded alcohols and phenols. The peak at 2154cm-1 corresponds to O-H stretch carboxylic acids. The assignment at 1650 cm-1 corresponds to N-H bend primary amines. The peak at 742 cm-1 corresponds to C-Cl stretch. FT-IR analysis revealed the carbonyl group from amino acid residues and proteins. SEM image has shown individual silver particles as well as a number of aggregates. The morphology of the silver nanoparticles was predominately spherical and aggregated into larger irregular structure with no well-defined morphology observed in the micrograph (Fig.5).

4. CONCLUSION

Indigofera aspalathoids leaf extract was found suitable for green synthesis of silver nanoparticles. The green synthesis of silver nanoparticles can be further applied in various biotechnological fields and their properties and applications can further be explored.

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Conflict of Interest

The authors declare no conflicts of interests any matter related to this paper.

Data and materials availability

All related data have been presented in this paper.

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